Marketing Opportunities for Certified Pork Chops

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U.S. consumers are increasingly concerned about food safety, environmental degradation, and animal welfare at the live animal production stage. In response, meat suppliers are developing food credence certification to secure market access, increase margins, and increase overall demand. The objective of this paper is to characterize the demand and the market potential of a credence certification program for pork in the United States. Information regarding consumer willingness to pay for the conventional and certified products is derived from a latent class random utility model. The willingness to pay estimates are subsequently compared to the costs of implementing the programs at the producer, packing, and retailing stages. One of the findings in this study is that a significant segment of consumers would purchase certified pork at the anticipated marginal cost of certification. Therefore, future studies should consequently focus on the welfare economic implications on consumers and meat suppliers from incomplete adoption of voluntary certification programs on the part of both producers and consumers.

INTRODUCTION

Changing public perceptions of food quality attributes in the United States are forcing food suppliers to adopt new marketing strategies. There are public concerns that the agricultural and food manufacturing sectors cause environmental degradation, treat food animals unethically, and are threatening the food safety through unsafe farming practices. The problem is that there is incomplete information about important product and process characteristics in meat products because these characteristics cannot be observed or verified prior to or after purchase. Such attributes are often referred to as credence
attributes (Darby and Karni 1973). Hence, concerns about certain food products with credence attributes may decrease demand, as some consumers switch to a substitute that alleviates the information problem or boycott the product altogether, e.g., van Ravenswaay and Hoehn (1996). Consequently, as interest groups with stakes in environmental issues and/or food safety demand more stringent food regulations, food producers have incentive to be proactive in addressing the growing tide of consumer awareness.

The natural or organic foods sector is an example where substantial change is taking place in this regard. Demand for organic food products is a growing segment because an ever-larger group of consumers see a personal and social benefit from switching from conventional to organic produce and have sufficient income to do so. Macilwain, for example, argues, “Today, support for organic farming is frequently part of a bigger social and political mindset—one that holds that ‘natural’ is best” (Macilwain 2004, p. 792); see also Whitfield (2002), Nelson et al (2004), and Dhar and Foltz (2005).1

The ethical treatment of live animals is another growing concern among consumers in the developed world. In 2004, the U.S. Department of Agriculture (USDA) published a note in the Federal Register asking suppliers to ensure compliance with current animal welfare regulations because of “considerable congressional and public interest about the humane treatment of animals” (USDA 2004, p. 54625).

Food safety is also a prevalent issue that has spun out of food-borne illnesses such as salmonellosis that can be contracted from food products contaminated by salmonella bacteria; and the variant Creutzfeldt-Jakob disease (vCJD) that may be acquired by the consumption of beef from cows infected with bovine spongiform encephalitis (BSE). With respect to BSE-vCJD, special interest groups are concerned that there is a food safety issue because not sufficient animals are tested for BSE (U.S. General Accounting Office (GAO) 2005). Another highlighted food safety issue is the potential emergence of antibiotic-resistant bacteria from animals that are fed subtherapeutic doses of antibiotics (Tollefson and Miller 2000; Tollefson and Karp 2004; GAO 2004; Schaefer-Munoz 2005).

In response, food suppliers are developing various certification and quality assurance programs to meet consumer and public concerns regarding environmental degradation, treatment of live animals, and food safety.2 Suppliers can thus use the certification program as a strategy to differentiate among consumers with varying preferences or information needs and potentially expand total consumption because there is an increase in the heterogeneity of product offerings. The problem for the supplier is that gathering, guaranteeing, and providing food quality information is an inherently costly activity (Antle 2001). Moreover, the natural time lag associated with biological production implies that supply often cannot completely respond in an instantaneous fashion to changes in consumer demand. Furthermore, it is possible that conventional marketing channels can co-exist with its certified counterparts because not all consumers may prefer the certified product.

The objective of this study is to characterize the demand and the potential marketability of credence certification programs for fresh pork cuts in the United States. The credence certification programs would guarantee to the consumer that strict third party-developed environmental, animal welfare, and antibiotic-use standards were followed in the production and processing of the product from farm to retail stages.3 This study estimates the willingness to pay for food products with certified credence attributes
and calculates demand elasticities to analyze the degree of substitutability between the conventional product and its certified counterpart. In addition, the willingness to pay estimates are compared to the cost premiums associated with implementing the certification programs from Roller (2004), who studied the cost of implementing such programs.

CONCEPTUAL MODEL

Consumers are modeled in accordance with random utility maximization (RUM) theory of the type described by McFadden (1974) and Hanemann (1984). Consider the nth individual in a population of N consumers with potentially heterogeneous preferences. Each consumer chooses among a discrete finite set of products, \( C = \{L, H, O\} \), where \( L \) refers to the conventional product, \( H \) the certified product, and finally \( O \) is the no-purchase option. The certified product can be certified for the environment, animal welfare, proper antibiotic usage, or a combination of the certification protocols; and each program is further described in Table 1. The seven combinations are denoted as \( H = \{\text{ENV}, \text{WEL}, \text{ANT}, \text{E&W}, \text{E&A}, \text{W&A}, \text{EWA}\} \), where the first three credence attributes are referred to as the single-credence attribute programs (environment, animal welfare, and antibiotics) and the subsequent three are referred as the double-credence attribute programs (environment & animal welfare, environment & antibiotics, and animal welfare & antibiotics). The last one is the triple-credence attribute program: environment, animal welfare, and antibiotics combined.

For notational convenience, denote the restricted set choice for the conventional and certified product as \( Q = \{L, H\} \). The conventional and certified products are described by a three-by-one attribute vector \( x_i = [x_{B,i}, x_{P,i}, x_{Q,i}]' \) for \( i = L, H \), where the first element is the brand indicator, the second the certification indicator, and the third the product price for the ith product. The nth consumer's conditional indirect utility function for the ith product \( V_{ni} \) is,

\[
V_{ni} = v_{ni}(x_i; \beta_n) + u_{ni} \tag{1}
\]

where \( v_{ni}(x_i; \beta_n) \) is referred to as the part-worth utility and \( u_{ni} \sim (I, \Sigma) \) is the idiosyncratic error term. If the error terms are IID extreme value type I, the resulting likelihood function reduces to that of McFadden's conditional Multinomial Logit. For reasons explained below, the part-worth utility is assumed to vary between consumer segments and the error terms are assumed to be IID extreme value type I within each segment. The part-worth utility is a function of product levels as well as a marginal utility vector \( \beta_n = [\beta_{n,B,i}, \beta_{n,P,i}, \beta_{n,Q,i}]' \). Thus, the indirect utility may vary across individuals and product choices. From the Lancastrian perspective, the part-worth utility could be regarded as the consumption technology (Lancaster 1966, p. 135), where the error term varies across individuals and product choices.

The indirect utility function is specified as a second-degree polynomial, which allows for subadditivity or superadditivity between pairs of credence attributes,

\[
v_{ni}(x_i; \beta_n) = \beta_{n,B,i}x_{B,i} + \beta_{n,P,i}x_{P,i} + \sum_{k \in i} \sum_{l \in i} \beta_{n,Q,k,l}x_{Q,k}x_{Q,l} \tag{2}
\]
The functional form implies strong separability between income and other demographic variables, and product attributes in the utility specification, e.g., the demand for fresh pork cuts represents a small share of total expenditure; see LaFrance (1985), McConnell (1995), and Nevo (2003).

Moreover, a maintained hypothesis is that there is no substitute-complement pattern between brands and certification attributes. Thus, the specification does not include interaction terms between credence attributes and the brand, where the brand is a proxy for search or experience attributes. Furthermore, the price variable enters linearly in the utility function, which considerably simplifies calculation of elasticities and willingness to pay.

Demand is derived in traditional RUM fashion where the probability that the \( n \)th consumer chooses the \( i \)th product, denoted as \( \Pr[y_{ni} = 1] \) is

\[
\Pr[y_{ni} = 1] = \Pr\left[ v_{ni}(x_i; \beta_n) - v_{nj}(x_j; \beta_n) \geq u_{nj} - u_{ni}, i \neq j \forall i \in C \right] \quad (3)
\]

Thus, demand is a function of the relative differences in part-worth utilities and the joint distribution of the error terms. Moreover, the specification allows consumers to have heterogeneous preferences with respect to the credence program(s) because the indirect utility may vary within the population.

**ECONOMETRIC MODEL**

The latent class model, also referred to as the “finite mixture model” in the marketing literature, captures consumer heterogeneity via the error term and allows the indirect utility function to follow a discrete finite support (Swait 1994). Hence, in this framework, the part-worth utility varies across consumer segments, i.e., the estimated utility parameters have a discrete number of support points and the error terms are conditional IID extreme value type I within each support point; for details, see Louviere et al (2000, p. 205). The implication is that the sample of surveyed consumers can be segmented into a discrete number of market segments. The unconditional choice probability is,

\[
P[y_{ni} = 1] = \sum_{m=1}^{M} s_m \frac{\exp(v_{n,i,m})}{\sum_{j=1}^{C} \exp(v_{n,j,m})} \quad (4)
\]

where \( s = [s_1, s_2, \ldots, s_{m-1}, s_m] \) is the class probability, which are bounded between 0 and 1 and \( \sum_{m=1}^{M} s_m = 1 \), and \( v_{n,i,m} \) is the \( n \)th individual’s \( m \)th class part-worth utility for the \( i \)th product. The log-likelihood function is,

\[
\log L = \sum_{n=1}^{N} \sum_{i=1}^{C} y_{ni} \log \left[ \sum_{m=1}^{M} s_m \frac{\exp(v_{n,i,m})}{\sum_{j=1}^{C} \exp(v_{n,j,m})} \right] \quad (5)
\]

which is maximized with respect to (\( s, \beta \)). The number of segments or classes, \( M \), is specified prior to estimation. Boxall and Adamowicz (2002), Greene and Hensher (2003), and Hu et al (2004) discuss the estimation procedure and criterion for selecting the number of classes. In circumstances with little or no heterogeneity, only one of the classes will be significant, collapsing to the traditional Multinomial Logit model.
VARIANCE OF RANDOM VARIABLES

Calculating willingness to pay and elasticity estimates involve computing products of estimated parameters. The variance of the product is approximated using a first order Taylor series expansion; for details, see Mosak (1939) and Silberberg and Suen (2001). Dorfman et al (1990) find that the Taylor method in the linear regression case is relatively accurate in instances when the distribution of the error term is non-normal. The Taylor approximation is commonplace in contingent valuation studies using empirical models of discrete choice; see Blackburn et al (1994) and Langford (1998).

The willingness to pay is calculated as

\[ WTP = -\hat{\beta}_P \left( \sum_{i=H} \hat{\beta}_i \right), \]

where \( \sum_{i=H} \hat{\beta}_i \) is the sum of the estimated certification parameters in the restricted choice set \( H \), and \( \hat{\beta}_P \) is the estimated price coefficient. The variance of the willingness to pay estimate is

\[ \text{var}[WTP] = \sum_{i=H} \sum_{j=H} \sigma_{i,j} \left( \frac{\sum_{i=H} \hat{\beta}_i}{\hat{\beta}_P} \right)^2 + 2 \left( \frac{\sum_{i=H} \sum_{j=H,j\neq i} \sigma_{i,j}}{\hat{\beta}_P} \right) \]

where \( \sigma_{i,j} \) is the covariance between the \( i \)th and \( j \)th estimated parameter. The details of the derivation are available in Nilsson (2005).

The variance of the demand elasticity is derived next. Denote the market size as \( M \), then the total demand \( Q \) at price \( P \) for the \( i \)th product is \( Q(P, M) = M \Pr[y_i = 1] \). The price elasticity is defined as

\[ e_{ij} = \frac{\partial Q_i}{\partial P_j} \frac{P_j}{Q_i} \]

because the market size cancels algebraically, the demand price elasticity becomes a function of the choice probability, price level, and the estimated price coefficient. To simplify the notation, denote the choice probability as \( \Pr(y_i = 1) = y_i \), the coefficient of price as \( \hat{\beta}_P = \beta \), the predicted choice probability as \( \hat{y}_j = y_j \). The elasticity is,

\[ e_{ij} = \beta P \left( \delta_{ij} - y_j \right), \quad \delta_{ij} = 1 \quad \text{if} \quad i = j, \quad 0 \quad \text{otherwise} \quad i, j = L, H \]

where \( P_j \) is the price level. To further simplify the notation, let \( P_j = P \) and \( \delta_{ij} = \delta \). The expected value of the elasticity is \( E[e] = \hat{\beta}P[\delta - \hat{y}] \) and the variance is,

\[ \text{var}[e] = (P(\delta - \hat{y})^2 \text{var}[\beta] + (\hat{\beta}P)^2 \text{var}[y] - 2((P)^2 \hat{\beta}(\delta - \hat{y})) \text{cov}[\beta, y] \]

Four comments are important at this stage. First, this study considers only the price elasticities for the restricted choice set \( Q \). That is, the certification programs are mutually exclusive because suppliers would introduce only one of the certification programs. Second, the covariance term \( \text{cov}[\beta, y] \) is assumed to be zero. This is a frequent assumption in the linear regression context, e.g., Dorfman et al (1990, p. 1007). Third, the variance of the dependent variable is approximated as a binomial, e.g., \( \text{var}[y] = y(1 - y) \). The variance of the elasticity is,
\[
\text{var}[e] = (P (\delta - \hat{y}))^2 \text{var}[\beta] + (\hat{\beta} P)^2 y (1 - y)
\]

note that the price level influences the variance expression. Fourth, the elasticity presented here is the arithmetic aggregate elasticity. Davis and Wohlgenant (1993) and Louviere et al (2000, p. 60) argue that the geometric averaged elasticity may be more appropriate. However, the arithmetic average is used here because it is not possible to compute each individual choice probability from the finite choice set \( Q \) in a choice experiment (CE). In the CE context, the respondent faces different choices with different attributes, discussed further in the subsequent section.

The price level is important because it influences the point estimate as well as the variance estimate. There are three strategies for choosing the appropriate price level. The first strategy is to assume that there is no premium associated with the certified product. This assumption is unrealistic when there are additional costs associated with the certification program. The second strategy is to equate the price premium to the actual marginal cost of certification. However, when markets are imperfectly competitive, firm strategic behavior can influence the market price so that the price premium may exceed the actual marginal certification cost. The third strategy is to evaluate the elasticities at the reservation price. In this situation, the purchase probabilities for the conventional and the certified products are equal because the certified product price equals the willingness to pay plus the conventional price. This study calculates the elasticities using this latter approach. Hence, in this study, the own-price and cross-price elasticities indicate the degree to which the conventional and the certified products are substitutable within each consumer segment (or latent class) in a situation where the purchase probabilities are equal.

**EMPIRICAL APPLICATION**

Choice-based conjoint analysis and CEs are economically efficient methods for collecting data regarding consumer preferences for non-market goods, e.g., Adamowicz (2004), Brownstone and Train (1998), Louviere et al (2000), and Lusk et al (2003). As with many data collection tasks, however, there is a trade-off between response fatigue and the number of responses required for conducting an appropriate statistical analysis. The CE in this application is designed as a fractional factorial design so that the main effects and the two-way interaction effects are orthogonal across and within each choice set (Louviere et al 2000; Lusk and Norwood 2005). To combat the problem of response fatigue and a subsequently lower response rate, the CE contains 64 questions, blocked in 4 blocks of 16 questions in each group. That is, each respondent completed one survey block, which consisted of 16 questions. This type of experimental design allows for identification of main effects and two-way interaction effects.

Each question consists of five alternatives, including a non-purchase option. Each alternative has five attributes: brand, price, and indicators for the certification programs. Table 1 defines the pork chop attributes used in the CE and reports the levels with which the attributes were varied across choice options and choice sets. A sample CE question is shown in Figure 1.

In January 2004, 7,200 surveys were mailed to a sample of representative households in the United States. The final response rate was 11% and after eliminating
Table 1. Pork attributes and attribute levels in choice experiment

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Definition</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand</td>
<td>Pork chop brand name</td>
<td>Tyson, Hormel, Store brand, No brand</td>
</tr>
<tr>
<td>Price</td>
<td>U.S. dollars per pound</td>
<td>$3.00, $3.30, $3.60, $4.00</td>
</tr>
<tr>
<td>Environmentally certified (ENV)</td>
<td>Requires that the farmer follow an environmental plan that is approved by the International Standards Organization (ISO), which controls the disposal of waste and the location of the farm relative to houses and water in order to reduce pollution and odor nuisances</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Certified for animal well being (WEL)</td>
<td>Requires that the farmer and the processor both meet the specifications developed by the Food Marketing Institute (FMI) and the National Council of Chain Restaurants (NCCR) for proper animal care, housing, and transportation</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Certified free of antibiotics (ANT)</td>
<td>Requires that pigs have received no antibiotics through feed or injections during their entire life</td>
<td>Yes, No</td>
</tr>
</tbody>
</table>

Incomplete surveys, there were 642 surveys available for analysis. Each respondent answered 16 questions, with 5 options per question, so that the resulting data set consists of 10,272 choices between 51,360 alternatives. The survey also asked the respondents to complete a set of demographic and attitudinal questions in addition to the CE questions. The average age, household income, and household size in the sample is 53 years, 55 thousand dollars, and 2.52 members, respectively. The sample corresponds well to U.S. Census data. According to U.S. Census data, the average age is 46 years, household income is 42 thousand dollars, and household size is 2.59 members. Because the survey targeted the primary household shopper, 61% of the respondents were women.

<table>
<thead>
<tr>
<th>Option / Attribute</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand Name</td>
<td>Hormel</td>
<td>Tyson</td>
<td>Store Brand</td>
<td>No Brand</td>
<td>I would not purchase any of these products</td>
</tr>
<tr>
<td>Price ($/lb)</td>
<td>$4.00</td>
<td>$3.60</td>
<td>$3.00</td>
<td>$3.30</td>
<td></td>
</tr>
<tr>
<td>Environmentally Certified</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certified for Animal Well Being</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certified Free of Antibiotics</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><strong>I would choose</strong> . . .</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Figure 1. Example of a choice experiment question
RESULTS AND FINDINGS

According to Eq. (2), the choice probability is a function of the price level, brand indicator variables, and single-, double-, and triple-credence certification indicator variables. Moreover, the parameters are allowed to vary between the latent classes. Although there is no absolute statistical criterion for choosing the appropriate number of latent classes, it is desirable that the estimates should carry economically relevant information regarding consumer behavior. Moreover, there is a strand of literature in psychology that suggests that consumer preference with respect to product attributes has discrete finite support; see Schwartz (2004) and Schwartz et al (2002). Schwartz et al argue that members of one group of consumers desire to catalog all products and their characteristics prior to purchase, whereas members of another group settle for products that are “good enough.” For the latter group, “[a]dding options in a domain in which he has already encountered something good enough need have no effect; the new options may simply be ignored” (2002, p. 2).

The latent class model can be a relatively good approximation of the underlying preference distribution in the sample. Specifically, in this application, the conventional and certified pork chops differ only on the basis of the presence of a credence attribute. It is likely that a particular consumer might be somewhat supportive, against, or indifferent toward the particular issue(s) being addressed by the certification program. Therefore, there may be relatively strong within-group preference homogeneity but relatively strong preference heterogeneity between different consumer groups. The model fitted here contains three latent classes; see Table 2. The results seem to validate the arguments set forth by

<table>
<thead>
<tr>
<th>Class/Parameter</th>
<th>Class 1: Attribute conscious</th>
<th>Class 2: Price conscious</th>
<th>Class 3: Concerned shoppers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>0.161 (0.026)</td>
<td>0.413 (0.022)</td>
<td>0.426 (0.021)</td>
</tr>
<tr>
<td>Hormel</td>
<td>−3.049 (0.800)</td>
<td>9.857 (0.132)</td>
<td>2.200 (0.197)</td>
</tr>
<tr>
<td>Tyson</td>
<td>−2.941 (0.794)</td>
<td>9.791 (0.131)</td>
<td>2.071 (0.194)</td>
</tr>
<tr>
<td>Store brand</td>
<td>−3.176 (0.808)</td>
<td>9.997 (0.133)</td>
<td>2.170 (0.197)</td>
</tr>
<tr>
<td>No brand</td>
<td>−3.734 (0.814)</td>
<td>8.837 (0.130)</td>
<td>1.462 (0.188)</td>
</tr>
<tr>
<td>PRICE</td>
<td>−0.688 (0.162)</td>
<td>−2.336 (0.030)</td>
<td>−1.349 (0.043)</td>
</tr>
<tr>
<td>ENV^a</td>
<td>1.777 (0.594)</td>
<td>0.561 (0.058)</td>
<td>1.951 (0.115)</td>
</tr>
<tr>
<td>WEL^a</td>
<td>0.166 (0.471)</td>
<td>0.606 (0.056)</td>
<td>2.446 (0.120)</td>
</tr>
<tr>
<td>ANT^a</td>
<td>1.830 (0.574)</td>
<td>0.453 (0.059)</td>
<td>3.366 (0.122)</td>
</tr>
<tr>
<td>E&amp;W^a</td>
<td>1.983 (0.371)</td>
<td>0.078* (0.063)</td>
<td>−0.100* (0.088)</td>
</tr>
<tr>
<td>E&amp;A^a</td>
<td>0.247* (0.565)</td>
<td>−0.066* (0.068)</td>
<td>−0.474 (0.094)</td>
</tr>
<tr>
<td>W&amp;A^a</td>
<td>1.197 (0.361)</td>
<td>−0.062* (0.061)</td>
<td>−0.255 (0.098)</td>
</tr>
</tbody>
</table>

Log-likelihood function value −10,539

Notes: Standard errors in parenthesis. * indicates that the parameter is not significantly different than 0 at the 1% level.

^aENV, WEL, and ANT are the certification schemes for the environment, animal welfare, and antibiotics schemes, respectively. E&W, E&A, and W&A are the certification schemes for the combinations environment & welfare, environment & antibiotics, and welfare & antibiotics, respectively.
Hu et al (2004), Lusk (2003), and Lusk and Hudson (2004) that consumer heterogeneity is a prevalent empirical observation when studying demand for food attributes.

The three groups differ substantially, with associated class probabilities of 16%, 41%, and 43%. That is, there is a 16% probability that a randomly chosen respondent belongs to the first class, 41% probability that a respondent belongs to the second class, and 43% probability that a respondent belongs to the third class. It is rather interesting to note the relatively large difference in magnitude between the parameters within each model.

For example, the non-linear coefficients are significant for the first class, except the environment–antibiotics parameter, and the third class, except the environment–welfare parameter, whereas they are not significant for the second class. The brand parameters are negative for the first class, indicating that a member of this class of consumers prefers not to consume conventional pork chops in general. However, the certification parameters are positive and significant. Hence, a member of this class would consume pork chops that are certified for at least two or all certification programs because of considerable concern about animal welfare, environmental degradation, and food safety. Furthermore, the price coefficient is relatively small, indicating that this segment is relatively price insensitive. This class appears to represent consumers with relatively high willingness to pay for certification attributes. This group is referred to as the “attribute-conscious” group.

For the second class, the brand parameters are large and significant, indicating that the members of this class prefer consuming a conventional pork chop relative to none at all. The certification parameters, however, are relatively small; so a member of this class may not enjoy as much utility from consuming a certified pork chop as compared to the first class. Moreover, the price coefficient is approximately four times as large as the linear certification parameters, which indicates that members of this class are relatively price sensitive. Therefore, this class may represent pork eaters who are relatively price conscious but relatively less concerned about the credence attributes. This group is referred to as the “price-conscious” group.

The third class has the largest class probability estimated at 43%. This class appears to be situated between the other two classes in preference space. A member of this class enjoys consuming a conventional pork chop as compared to none at all. However, the estimated certification parameters are as large as the brand parameters for this class. Members of this class prefer the certified product, but if the price premium is too high, then they would choose the conventional product instead. For want of better terminology, this class is referred to as the “concerned shoppers.”

In summary, it is interesting to note that the latent class model presents a rather interesting story in which the majority of consumers have additive or subadditive preferences in certification space. That is, the second and third classes experience a decreasing marginal utility from increasing the amount of credence certification. This finding also confirms the theoretical arguments set forth by Lusk (2003) in which he surmised that there might be consumers who have a diminishing marginal patience of reading the labeling. One could moreover present this finding as a case of support for Schwartz et al (2002), in that the attribute-conscious group consists of maximizers whereas the price-conscious and concerned shoppers are satisficers because for the latter two groups, their utility does not increase as the number in the number of credence attributes increases.
Table 3. Willingness to pay for credence certification in U.S. dollars per pound

<table>
<thead>
<tr>
<th>Class/Program</th>
<th>Class 1: Attribute conscious</th>
<th>Class 2: Price conscious</th>
<th>Class 3: Concerned shoppers</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENV&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.582 (1.086)</td>
<td>0.240 (0.025)</td>
<td>1.447 (0.095)</td>
</tr>
<tr>
<td>WEL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.242&lt;sup&gt;*&lt;/sup&gt; (0.688)</td>
<td>0.259 (0.025)</td>
<td>1.814 (0.105)</td>
</tr>
<tr>
<td>ANT&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.660 (1.004)</td>
<td>0.194 (0.026)</td>
<td>2.496 (0.115)</td>
</tr>
<tr>
<td>E&amp;W&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.705 (1.529)</td>
<td>0.532 (0.019)</td>
<td>3.187 (0.150)</td>
</tr>
<tr>
<td>E&amp;A&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.601 (1.581)</td>
<td>0.406 (0.029)</td>
<td>3.592 (0.156)</td>
</tr>
<tr>
<td>W&amp;A&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.641 (1.373)</td>
<td>0.427 (0.031)</td>
<td>4.121 (0.162)</td>
</tr>
<tr>
<td>EWA&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.464 (2.470)</td>
<td>0.671 (0.014)</td>
<td>5.143 (0.193)</td>
</tr>
</tbody>
</table>

Notes: Standard errors in parenthesis; * indicates that the parameter is not significantly different than 0 at the 5% level.
<sup>a</sup>ENV, WEL, and ANT are the certification schemes for the environment, animal welfare, and antibiotics schemes, respectively. E&W, E&A, and W&A are the certification schemes for the combinations environment & welfare, environment & antibiotics, and welfare & antibiotics, respectively. EWA is the certification scheme for all three programs.

Willingness to Pay

Willingness to pay estimates for the certification programs are presented in Table 3. For the first class, the estimates range from 2.58 to 10.64 dollars per pound, depending on the particular certification program. The variability in the attribute-conscious group, measured as the confidence interval is relatively wide. Moreover, it is only for the animal welfare certification program that the willingness to pay is insignificantly different from zero. The reported average retail price for pork chops in 2004 was 3.45 dollars per pound (USDA 2006a). Hence, the price premium the attribute-conscious consumer is willing to pay for certified pork ranges from 75% for the environment scheme to just over 300% for the triple-credence attribute certification program.

While the estimate may be considered to be on the high-end, it is important to bear in mind that not all consumers are willing to pay this price premium: there is a 16% probability that a randomly chosen respondent falls in this group. Nevertheless, the standard error for the attribute-conscious group is rather large, which indicates that this group is relatively heterogeneous. That is, although the consumers belonging to this class may be concerned about the environment, animal welfare, and antibiotics usage, the differences may be constituted in perceptions as to the degree to which the certification programs can alleviate their concern, which ultimately affect the shopping behavior.

The findings reported here are supported by previous studies. Revealed and stated preference studies indicate that some consumers are willing to pay, and are paying, high price premiums for products with certain credence attributes. For example, using grocery-store scanner data from four metropolitan regions in the United States, Dhar and Foltz (2005) found that the price premium for organic and r-BST free milk range from 60% to over 100%. Price premiums for organic vegetables in California are on an average 150% (USDA 2006b). Boxall et al (2003) studied consumer preferences for wild berry jams produced by aboriginal communities in Canada. Using a CE akin to this study, respondents were willing to pay up to twice as much for jam produced by aboriginal
communities than its conventional counterpart. Lusk et al (forthcoming) conducted a stated and a revealed preference survey of consumer preferences for “antibiotic-free pork chops” and found that on an average, consumers were willing to pay up to 80% more for the antibiotic-free pork chops.

Continuing, for the price-conscious group, the willingness to pay estimates range from 0.19 dollars per pound for the antibiotics certification program to 0.67 dollars per pound for the triple certification scheme. Moreover, the differences between the single attributes are not significant within the class at the 5% level. The price premium the price-conscious group is willing to pay for a certified pork chop ranges from 6% to 19%. In comparison with the attribute-conscious group, the willingness to pay estimates are relatively small, but nevertheless, significantly different from zero at the 5% level. Hence, this particular group of consumers is not especially concerned about the private good provision of the particular program.

The willingness to pay for the concerned shoppers range from 1.45 dollars per pound for the environment program to 5.14 dollars for the triple certification scheme, equivalent to a 37% to 140% price premium. For this segment, the willingness to pay estimates are significantly higher than the price-conscious class for all seven certification programs at the 5% level. On the other hand, the willingness to pay estimates between the concerned shoppers and the price-conscious group for the single and double attribute certification programs are statistically insignificant at the 5% level. However, the willingness to pay for the triple certification program is statistically significant between the two groups at the 5% level.

In summary, the two largest groups, the price-conscious and concerned shoppers, have significantly different preferences with respect to credence certification. The price-conscious group has constant marginal utility in certification space and has a relatively low willingness to pay for credence attributes. It may be that this particular group of respondents cares less about credence attributes because they perceive that there is no incomplete information problem. The concerned shoppers on the other hand, have significantly higher willingness to pay for the certification programs. This group may perceive that there is a need for credence certification programs. The group is nevertheless price sensitive and opts to consume the conventional pork chop if the certified price premium is too high.

Elasticities

As indicated by the parameter estimates and the willingness to pay estimates, the degree of product substitutability between the conventional and certified products varies between consumer segments. While as the price-conscious group is relatively more price sensitive than the attribute-conscious group, the concerned shoppers are situated between the two latter segments. However, an intriguing question is, are the demand elasticities for the conventional and certified products significantly and economically different if the purchase probabilities are equal?

The demand elasticity is computed for each class individually at a price level for which the consumer is indifferent between the conventional and the certified products. The own- and cross-price elasticities for the attribute conscious (first three columns), price conscious (columns four through six), and concerned shoppers (last three columns) are displayed in Table 4. For example, the own-price elasticity for the environmentally certified product (ENV) is $-2.08$ for the attribute-conscious segment; $-4.31$ for the price-conscious segment; and $-3.30$ for the concerned shoppers. Furthermore, if the price for the conventional
Table 4. Demand price elasticities

<table>
<thead>
<tr>
<th>Class 1: Attribute conscious</th>
<th>Class 2: Price conscious</th>
<th>Class 3: Concerned shoppers</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENV</td>
<td>CONV</td>
<td>ENV</td>
</tr>
<tr>
<td>ENV</td>
<td>-2.08 (0.43)</td>
<td>1.19 (0.28)</td>
</tr>
<tr>
<td>CONV</td>
<td>2.08 (0.49)</td>
<td>-1.19 (0.26)</td>
</tr>
<tr>
<td>WEL</td>
<td>CONV</td>
<td>WEL</td>
</tr>
<tr>
<td>ENV</td>
<td>-1.27 (0.28)</td>
<td>1.19 (0.28)</td>
</tr>
<tr>
<td>CONV</td>
<td>1.27 (0.30)</td>
<td>-1.19 (0.26)</td>
</tr>
<tr>
<td>ANT</td>
<td>CONV</td>
<td>ANT</td>
</tr>
<tr>
<td>ENV</td>
<td>-2.10 (0.44)</td>
<td>1.19 (0.28)</td>
</tr>
<tr>
<td>CONV</td>
<td>2.10 (0.50)</td>
<td>-1.19 (0.26)</td>
</tr>
<tr>
<td>E&amp;W</td>
<td>CONV</td>
<td>E&amp;W</td>
</tr>
<tr>
<td>ENV</td>
<td>-3.15 (0.61)</td>
<td>1.19 (0.28)</td>
</tr>
<tr>
<td>CONV</td>
<td>3.15 (0.75)</td>
<td>-1.19 (0.26)</td>
</tr>
<tr>
<td>E&amp;A</td>
<td>CONV</td>
<td>E&amp;A</td>
</tr>
<tr>
<td>ENV</td>
<td>-3.11 (0.60)</td>
<td>1.19 (0.28)</td>
</tr>
<tr>
<td>CONV</td>
<td>3.11 (0.74)</td>
<td>-1.19 (0.26)</td>
</tr>
<tr>
<td>W&amp;A</td>
<td>CONV</td>
<td>W&amp;A</td>
</tr>
<tr>
<td>ENV</td>
<td>-2.78 (0.55)</td>
<td>1.19 (0.28)</td>
</tr>
<tr>
<td>CONV</td>
<td>2.78 (0.66)</td>
<td>-1.19 (0.26)</td>
</tr>
<tr>
<td>EWA</td>
<td>CONV</td>
<td>EWA</td>
</tr>
<tr>
<td>ENV</td>
<td>-4.79 (0.79)</td>
<td>1.19 (0.28)</td>
</tr>
<tr>
<td>CONV</td>
<td>4.79 (1.14)</td>
<td>-1.19 (0.26)</td>
</tr>
</tbody>
</table>

Notes: Standard errors in parenthesis. ENV, WEL, and ANT are the certification schemes for the environment, welfare, and antibiotics, respectively. E&W, E&A, and W&A are the certification schemes for the combinations environment & welfare, environment & antibiotics, and welfare & antibiotics, respectively. EWA is the certification scheme for all three programs. CONV is the conventional product.
product (CONV) decreases by 1%, the demand for the environmentally certified product decreases by 1.19% for the attribute conscious, 4.03% for the price conscious, and 2.33% for the concerned shoppers. All elasticities are significantly different from 0 at the 5% level. Moreover, the differences in elasticity estimates between the three groups are statistically significant for the single certification programs, i.e., environment, animal welfare, and antibiotics usage, and the double certification program animal welfare & antibiotics usage at the 5% level. For the environment & antibiotics and the environment & animal welfare programs, the price elasticities are significantly lower for the attribute-conscious group than for the price-conscious group and the concerned shoppers. However, the difference in price elasticities between the latter two groups is not significant. Moreover, the price elasticities are not significant between the three groups for the triple certification, i.e., the environment & animal welfare & antibiotics usage program at the 5% level.

As the number of certification attributes increases within each class, the own-price elasticity increases. For example, for the attribute-conscious class, the own-price elasticity ranges from $-1.27$ (WEL) to $-4.79$ (EWA); for the price conscious from $-4.26$ (ANT) to $-4.81$ (EWA); and for the concerned shoppers from $-3.30$ (ENV) to $-5.79$ (EWA). Hence, the demand elasticity estimates indicate that although the purchase probabilities are equal, the degree of substitutability varies considerably between the three consumer segments. For example, one reason the elasticity for the attribute-conscious group is relatively small in magnitude might be that this group considers the products to be relatively highly imperfectly substitutable. On the other spectrum is the price-conscious group. One could surmise that because they see relatively little benefit coming from the certification program, they regard the certified and conventional products as perfect substitutes. The concerned shoppers are situated between the attribute and the price-conscious groups. They consider the certified products to be an imperfect substitute for the conventional but not to the same extent as the attribute-conscious group.

**Cost Estimate Comparison**

Roller (2004) studied four types of certification programs, namely an environmental, animal welfare, antibiotics usage, and a certification program that contained all three components. He inferred the increase in marginal cost from interviewing experts and researchers in Indiana. The programs increase the cost of production throughout the marketing channel for farmers, packers, and retailers. The costs consist of program fees as well as compensations for increased production costs and shelf space.

For the pork producer and packer, there is an initial increase in cost because the pork producer and packer must segregate batches if there are both conventional and certified live animals in the facility. The programs may also increase costs of production at the farm level because of stricter regulations related to housing requirements, manure disposal, etc. The retailer costs consist of creating additional shelf space for the product and provide a consistent product labeling, in addition to any promotion expenses.

Moreover, not all the cuts can be certified because many products contain mixed ingredients and cannot be kept separate from the conventional pork products in the processing stages, e.g., sausage and ham. Foster (2004) extended Roller’s (2004) study and calculated the cost of the program by assuming that only fresh primal cuts of pork will be labeled at the retailing stages. Under this assumption, 25% of the animal retail weight bears the certification costs accrued along the production and marketing channel. Foster
estimated that the increase in marginal cost at the retail stages for the environment, animal welfare, antibiotics, and the triple combination is 80, 160, 56–96, and 212–232 cents per pound, respectively. In comparison with the willingness to pay estimates, it can be readily seen that the consumers in the second segment, the price conscious, are not willing to pay the premium associated with the certification protocol. For the attribute-conscious group, the willingness to pay exceed the marginal cost increments for all programs except the animal welfare program, i.e., environment, antibiotics, and the triple combination. The concerned shoppers would consider all four programs.

SUMMARY AND CONCLUSIONS

The economic information concerning consumer willingness to pay becomes particularly insightful when allowing for heterogeneity in consumer preferences. The findings presented here show that it is essential to account for preference heterogeneity, particularly when modeling consumer demand for food with credence characteristics. The results indicate that the majority of respondents are concerned about credence characteristics related to the environment, animal welfare, and antibiotics. These consumers view the certified products as imperfect substitutes for the conventional product and have a significant willingness to pay for schemes that guarantee these attributes.

The attribute-conscious group, which represents 16% of the sample, has the highest willingness to pay. However, there is a great variation of the preferences for credence certification and so the standard errors are relatively large. The second group, referred to as the price-conscious group, has the lowest willingness to pay. The associated class probability for this group is 41%. The class probability for the third group, referred to as the concerned shoppers, is 43% and their preferences are situated in between the attribute and the price-conscious groups. The concerned shoppers have a positive significant willingness to pay for the certification programs. However, the concerned shoppers are not willing to pay as high price premium as the first group and opt for the conventional product if the price is too high. Therefore, from a policy perspective, it is crucial to investigate how the degree of consumer heterogeneity affects the economic viability of a voluntary certification scheme because the conventional product may be viewed as a perfect substitute by a large population share.

Comparing the cost estimates presented by Roller (2004) and Foster (2004) with the willingness to pay estimates seems to indicate that there is some market potential among the concerned shoppers and the attribute-conscious groups for the certification programs. Therefore, if a labeling program targets the group of consumers who perceive that credence characteristics are important, it is also important to analyze how other consumer segments view the certified products, and moreover consider the welfare impact of voluntary labeling policies on consumers and suppliers.

NOTES

1 According to Datamonitor (2004) and Organic Trade Association (OTA) (2005), the market value of meat marketed as organic or natural in the U.S. meat represented approximately 2% of sales of all meat in 2003. However, sales of organic food have grown approximately 20%, annually.

2 Roller (2004) and Nilsson (2005) provide an overview of some of these programs in-depth with detailed discussions regarding the pros and cons of the programs.
Details for each program are presented in Roller (2004) and Nilsson (2005).

Because food suppliers would potentially commit to only one of the certification programs, it is assumed that there is no uncertainty regarding the consumer’s choice; see McFadden (1999) and Louviere et al (2000).

For example, increasing (superadditive) utility for a pair of attributes \( \{x_j, x_{j+1}\} \) implies \( v_m(x_j + x_{j+1}) > v_m(x_j) + v_m(x_{j+1}) \), whereas decreasing (subadditive) utility for a pair of attributes implies \( v_m(x_j + x_{j+1}) < v_m(x_j) + v_m(x_{j+1}) \). The economic interpretation is that the consumer regards the attributes as imperfectly substitutable, or complementary. For a continued discussion, see Nilsson (2005).

It is plausible that brands could be complements to certification. If this is true, the estimated willingness to pay for certification in this study is likely to be understated. However, a test of this is outside the scope of this study, but may warrant attention in future studies.

This specification implies that the indirect utility function is linear in income with a constant coefficient that does not vary across consumers (McFadden 1999, p. 258). The 90% confidence interval is calculated as, \( \text{WTP}_{0.9} = E[\text{WTP}] \pm 1.645 \sqrt{\text{var}[\text{WTP}]} \).

Models with more than three classes contain estimated class probabilities that are smaller than 10%. The utility parameters for those small classes were insignificant as well. Therefore, the model with three latent classes was deemed appropriate. Incorporating demographic information and attitudinal information could not improve the statistical performance of the model. That is, covariates such as age, gender, income, and attitudes regarding food habits were not significant. In the context of this paper, the result is expected, because of the strong separability assumption between certification attributes and demographic and attitudinal information.

A discrete choice model such as this one cannot contain an overall constant. The brand parameters are relative to the no-purchase option \( E \) in Figure 1.

The 95% confidence interval for the \( \text{WTP} \) is \( \hat{w} \pm 1.960 \times SE \), where \( \hat{w} \) is the willingness to pay estimate and \( SE \) the standard error.

If the confidence intervals for two different certification schemes are not overlapping, the willingness to pay are significantly different from each other at the 5% level.

Indiana is the fifth largest pork producer in the United States. So the estimates could potentially be relevant for producers in other Midwestern states as well.

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